PECOS RIVER WATERSHED, NEW MEXICO AND TEXAS

LETTER

FROM

ASSISTANT SECRETARY OF AGRICULTURE

TRANSMITTING

A SURVEY REPORT DATED JULY 1950, OF THE PECOS RIVER WATERSHED IN NEW MEXICO AND TEXAS, MADE UNDER THE PROVISIONS OF THE FLOOD CONTROL ACT APPROVED JUNE 22, 1936, AS AMENDED AND SUPPLEMENTED

MAY 28, 1952.—Referred to the Committee on Public Works and ordered to be printed with illustrations

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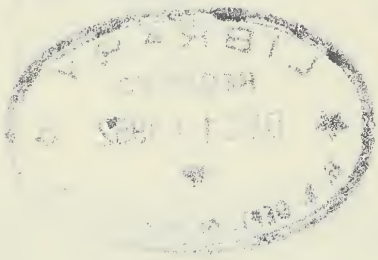
UNITED STATES
GOVERNMENT PRINTING OFFICE
20116 WASHINGTON : 1952



LETTER OF TRANSMITTAL

DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, May 20, 1952

The SPEAKER, HOUSE OF REPRESENTATIVES.

DEAR MR. SPEAKER: I am submitting herewith a survey report dated July 1950, together with accompanying papers and illustrations of the Pecos River watershed in New Mexico and Texas, made under the provisions of the Flood Control Act approved June 22, 1936, as amended and supplemented.

I recommend that the Secretary of Agriculture be authorized to carry out the program for runoff and water-flow retardation and soil-erosion prevention proposed in this report.

Enclosed are comments received from the representative of the Governor of New Mexico and interested Federal agencies.

The Department of Agriculture agrees with the recommendation of Lt. Gen. Lewis A. Pick, Chief of Engineers, favoring a joint study of the possible effects of the proposed channel-improvement works and the detention structure on downstream conditions. The program of this Department will be correlated to the fullest extent possible with the program of the Department of the Army prior to the initiation of construction of the structures or improvements involved.

The Bureau of the Budget, in its letter of March 6, 1952, advises that there is no objection to the submission of this report to the Congress. The Bureau further advises that it is in agreement with the objective contemplated in the report of carrying out measures designed to retard floods and prevent soil erosion, and that this objective is particularly desirable from the point of view of coordination of upstream measures with the flood-control programs of the Corps of Engineers and with the conservation programs of other Federal agencies. A copy of the letter from the Bureau of the Budget is enclosed.

Sincerely,

K. T. HUTCHINSON,
Assistant Secretary.

PECOS RIVER WATERSHED, NEW MEXICO AND TEXAS

LETTER FROM THE BUREAU OF THE BUDGET TO THE SECRETARY OF AGRICULTURE

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington 25, D. C., March 6, 1952.

The honorable the SECRETARY OF AGRICULTURE.

MY DEAR MR. SECRETARY: This will acknowledge receipt of Acting Budget Officer J. L. Wells' letter of January 30, 1952, requesting advice as to the relationship to the President's program of the proposals contained in your Department's report entitled "Survey Report, Pecos River Watershed, New Mexico and Texas."

Floodwater and sediment damages occurring in the Pecos River watershed are estimated to average $933,000 annually. The principal estimated annual losses are agricultural. Floods also cause damages to roads, railroads, and urban areas, while sediment damages occur to water supplies, drainage channels, reservoirs, irrigation systems, and public health.

It is proposed to alleviate these damages and to realize extensive associated benefits by installing a number of interrelated and interdependent soil and water conservation and control measures or groups of measures, mostly vegetative in character, during a 15-year period. These measures, applied in proper combination with other soil and water conservation practices and measures, would constitute a basic system of soil and water conservation in accordance with needs and capabilities of the land in the Pecos watershed. Educational assistance and technical services are also recommended as a part of the proposed program.

The estimated total cost of the recommended program, based on 1948 prices and an intermediate level of employment, is $20,126,300. The Federal Government would be expected to expend $14,683,800 of the total cost; non-Federal public agencies and private interests would contribute $5,442,500 or its equivalent in labor, materials, equipment, land, easements, rights-of-way, and other assistance in lieu of cash payments. Operation and maintenance of the recommended works of improvement are estimated to cost $337,840 annually, of which $115,975 would be paid by the Federal Government, and $221,865, or its equivalent, would be borne by local interests.

It is estimated that the recommended watershed program, if installed as planned and maintained adequately, will yield average annual benefits evaluated at $5,555,200. Reduction in ffoodwater damages is estimated at $270,500, reduction in sediment damages is estimated at $89,200, and conservation and increased water yield

benefits are estimated at $5,195,500. These benefits would result mainly from the provision of farm waterways, terraces, pasture development, floodwater-retarding structures, and other conservation measures.

The total average annual costs are estimated at $916,815. Since prices are expected to vary during the 15-year installation period, both benefits and costs were adjusted to anticipated future price levels by applying indexes provided by the Bureau of Agricultural Economics. Thus, the average annual benefits are adjusted to $2,431,700 and the costs, on the same basis, to $702,500. This adjustment results in a revised benefit-cost ratio of 3.5 to 1.0 for the recommended program.

The report has been reviewed by the Governors of New Mexico and Texas and by the several concerned Federal agencies, in accordance with policies and procedures for distribution and coordination of reports as adopted by the Federal Inter-Agency River Basin Committee. The views expressed are generally favorable to the proposed program, with suggestions limited to considerations that could be resolved cooperatively by the concerned agencies or local interests during the periods of planning and installing the watershed works of improvement. Comments, however, from the Department of the Army, Corps of Engineers, have not yet been received.

The work envisioned in the report constitutes predominantly open-land, farm, and woodland improvement measures which will produce very high conservation benefits, accruing mainly to landowners and farm operators in the form of increased returns due to improved practices. The program recommended includes an intensification, acceleration, and adaptation of soil and water conservation activities already in progress under going programs of the Department of Agriculture. These include such programs as the Conservation and Use program, authorized by the Soil Conservation and Domestic Allotment Act, approved February 29, 1936, as amended; the Soil Conservation Service's program of assistance to districts and other cooperators, authorized by the Act of April 27, 1935; and State and Private Forestry Cooperation, pursuant to the Act of August 25, 1950, sections 1 through 5 of the Act of June 7, 1924, and acts supplementary thereto.

The Bureau of the Budget is in agreement with the objective contemplated in the report of accelerating land treatment measures and installing structural measures designed to retard floods and prevent soil erosion. This objective is particularly desirable from the point of view of coordination of upstream measures with the flood control programs of the Corps of Engineers and with the conservation programs of other Federal agencies.

The measures contemplated to implement the proposed program may be grouped into two broad categories—land treatment measures and structural measures. The Bureau of the Budget is of the opinion that installation of the structural measures (shown in table 2, page 14 of the report as "Stabilizing and sediment control structures," "Road erosion control," "Diversion dikes and ditches," "Channel improvement," "Streambank protection," "Flood systems," "Detention structures," and "Salt cedar eradication and control") should properly be authorized under the Flood Control Act, as amended and supplemented. The Bureau also believes that the land-treatment measures

set forth in this report, since they are largely an acceleration of existing programs of the Department of Agriculture, should be financed under appropriations other than that for the Flood Control Act. This would avoid confusion in the presentation of the Department's budgetary program, since many of the current land-treatment programs of the Department have the objective of runoff and water-flow retardation and the prevention of soil erosion. To the extent that the acceleration of land-treatment measures under existing authorities is not possible, we urge that adequate authorities for such acceleration be sought through amendment of those basic authorities.

Your staff, on the other hand, believes that the Department cannot properly meet its responsibilities under the Flood Control Act unless the full program envisioned in the report is authorized under that act. Your representatives, however, agreed that appropriations for land-treatment phases implementing the program recommended in the report, upon approval by the Congress generally on the basis as submitted, would be sought as additions to going program appropriations of the agencies carrying on the work. Funds for structural works or measures would still be requested under the appropriation "Flood control." The total obligations for land-treatment and structural measures in each authorized flood-control project area could, of course, be shown in a summary table to be presented in the program and performance section of the annual budget document.

Subject to the above understanding as to the method of presenting the budget for flood-control programs, there would be no objection to the submission of the proposed Pecos River watershed flood-control survey report to the Congress. In the event the report or any modification thereof is approved by the Congress, submission of requests for appropriations must be justified in accordance with the policy set forth in the President's letter of July 21, 1950, which directed that all civil public works be considered with the objective, as far as practicable, of deferring, curtailing, or slowing down those projects which do not directly contribute to national defense or to civilian requirements essential to the changed international situation, or as may later be modified.

In submitting the Department's report to the Congress, it will be appreciated if you include a copy of this letter.

Sincerely yours,

ELMER B. STAATS,
Assistant Director.

LETTER FROM THE CHIEF OF ENGINEERS TO THE SECRETARY OF AGRICULTURE

DEPARTMENT OF THE ARMY,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, March 14, 1952.

The honorable the SECRETARY OF AGRICULTURE,
Washington, D. C.

DEAR MR. SECRETARY: In accordance with the request from the Assistant Secretary of Agriculture, enclosing for the information and comment of the Chief of Engineers the Department of Agriculture's survey report on the Pecos River watershed, New Mexico and Texas, I am pleased to submit the following comments.

The report recommends that the Federal Government undertake in the Pecos River Basin a program of runoff and water-flow retardation and soil-erosion prevention to be installed during a 15-year period at an estimated cost, based on 1948 prices, of $14,683,800 to the Federal Government and $5,442,500, or its equivalent, to local interests. The non-Federal participation may be in the form of labor, materials, equipment, land, easements, rights-of-way, and other contributions in lieu of cash payments. The estimated annual cost of operating and maintaining the recommended program is $115,975 Federal and $221,865, or its equivalent, non-Federal. Based on future price and cost levels assumed to prevail under an intermediate level of employment, the report states that the ratio of average annual benefits to average annual costs is 3.0 to 1.

With respect to the relation of your program to plans of the Corps of Engineers, your report states that particular attention has been given to evaluation of program recommendations to avoid duplicating benefits credited to works of improvement under consideration by the Corps of Engineers in a report on the Pecos River and tributaries which is now nearing completion in the field. During the period when the reports of the two departments were being coordinated, our studies were not sufficiently advanced to permit a definite commitment by the field officers on all plans for flood control on the main stem of the Pecos River. The field officers have subsequently determined the advisability of construction of a reservoir at the Los Esteros site which would give protection to an area in which your report has evaluated benefits; the magnitude of benefits involved in this section of possible duplication is relatively small.

It appears that the watershed improvement part of your program would conserve and improve the lands of the basin, and, while it alone will not control floods, it would supplement other measures for flood control and water conservation. I have no comment regarding the estimated costs or benefits of this part of the program.

The remainder of the program recommended in your report, involving about 10 percent of the total estimated cost, includes, 2.5 miles of channel rectification on the main stem and major tributaries, 45.5 miles of bank protection works, 14 miles of floodways for emptying 34 small earth-fill detention structures, and 1 large detention structure of 5,000 acre-feet capacity for control of a drainage area of 120 square miles. These works are closely related to flood-control improvements proposed and under consideration for construction in the Pecos River Basin by the Corps of Engineers. The data contained in the report is insufficient for specific comment as to the adequacy or economic justification of these measures. However, I am able to make certain general comments concerning these features.

Although the amount of channel rectification recommended in your report is small, the improvement of the flood-carrying capacities may have some significant effect on downstream flood discharges and problems. I am sure that you recognize the necessity for coordinating your detailed plans for these works with downstream flood-control requirements, particularly in view of the fact that the Department of Agriculture does not normally undertake work in major channels.

With regard to the 45.5 miles of bank-protection works at an estimated cost of $1,107,000, I am not convinced of the advisability of this construction. Based upon the economic principles in use by the

Corps of Engineers, your recommended bank protection lacks economic justification by a wide margin. I am therefore unable to concur in your recommendation for authorization of this portion of the proposed program.

The floodways recommended in your report are obviously for protection of relatively small areas and would have little effect outside of their immediate vicinities. On the assumption that it will not be found necessary to increase the size of these units appreciably above that of the sample on which the design and cost estimates are based, and that detailed studies will indicate their economic feasibility, I have no comments concerning them.

With regard to the Capitan detention dam, which would form a reservoir of about 5,000 acre-feet and control an area of 120 square miles, your report does not contain information sufficient to determine its structural adequacy or its effect on downstream flood problems with which this office is concerned.

In view of the possible effects of the proposed channel rectification works and the detention structure on downstream conditions, I would favor a recommendation that these portions of your program be made the subject of a further joint study by our two agencies prior to recommendation to Congress for authorization.

With the exceptions noted, I am in accord with your general program for retardation of water flow and flood control on the tributaries of the Pecos River Basin when they are demonstrated to be sound from engineering and economic standpoints.

I appreciate the opportunity to review your report.

Sincerely yours,

LEWIS A. PICK,
Lieutenant General,
Chief of Engineers.

LETTER FROM THE SECRETARY OF THE INTERIOR TO THE SECRETARY OF AGRICULTURE

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington 25, D. C., July 23, 1951.

Hon. CHARLES F. BRANNAN,
Secretary of Agriculture,
Washington 25, D. C.

MY DEAR MR. SECRETARY: In accordance with Federal Interagency River Basin Committee procedures, Assistant Secretary Hutchinson transmitted by letter dated March 12, 1951, for the information and comments of the Department, copies of the Department of Agriculture's survey report on the Pecos River watershed, New Mexico and Texas.

The report, dated July 1950, recommends a remedial watershed program to reduce floodwater and sediment damage and to conserve soil and water resources in the Pecos River Basin of New Mexico and Texas during a 15-year period at a total estimated cost of about $20,125,000, of which some $14,680,000 would be Federal cost and some $5,440,000, or its equivalent, would be the cost to local interests. The benefits to cost ratio is given as 3.0:1. As set forth in the report

this is over and above the cost of the going programs related to activities for flood control which is presently about $414,000 a year for the Department of Agriculture and $44,000 a year for the Department of the Interior. Measures to accomplish the objectives of the proposed program include stabilizing and sediment control structures, diversion dikes and ditches, seeding range land, rodent control, adequate fire control, stockwater facilities, fencing, terracing, crop residue management, tributary channel control, land acquisition, and other soil and water conservation practices and measures applied in proper combination with the above listed measures which will make up a comprehensive program of soil and water conservation in accordance with the needs and capabilities of the land of the watershed.

The report has been reviewed at regional level by the Geological Survey, the Bureau of Indian Affairs, the Bureau of Land Management, the Fish and Wildlife Service, the Bureau of Reclamation, the Bureau of Mines, the National Park Service, and the Southwest Field Committee. Opportunity for such field review in accordance with Federal Inter-Agency River Basin Committee procedures is appreciated.

The report is consistent with the pattern reflected in previous flood-control reports of the Department of Agriculture. It is evident that essentially all available data have been utilized in connection with the various analyses presented in the report. As in previous reports, many conclusions have been drawn on the basis of a few facts. As pointed out in the regional comment of the Bureau of Reclamation, the available data are inadequate for appropriate evaluation of runoff losses that would result from application of the remedial measures proposed in the program. Thus provision of means for evaluation of the effects and benefits achieved is a highly desirable element of the program. The Department endorses the provision of means for such evaluations and would welcome an opportunity to cooperate with your Department in these and other such studies.

Since many of the basic data used for this report were undoubtedly obtained from Geological Survey records, it would seem that appropriate references to these data in the report would be helpful to others and tend to assure the soundness of the foundation of the studies and report. This applies to basic topographic maps as well as hydrologic data.

A comprehensive program providing for the collection of actual field data on the effects of watershed improvement in the Pecos River Basin should be instituted, as an integral part of the recommended plan, for it is only on the basis of such data that the magnitude of runoff reductions and the values of sediment control and other benefits can be reliably appraised in connection with future proposals for improvement of other watersheds.

The Department of the Interior is definitely concerned with reduction of sedimentation to prolong the life of reservoir sites and thus help to perpetuate the irrigation economy of the basin. Although the values for sediment inflow into Pecos River reservoirs shown in the preliminary draft of the report have been modified substantially in this report since the Bureau of Reclamation reviewed the field draft, the adopted values are still significantly higher than those determined by the Bureau of Reclamation. It should be appreciated, however, that the benefits from reduction of reservoir sedimentation by 23 per-

cent, as estimated in this report, amount to only 1.6 percent of the total estimated benefits and, even if eliminated, would not greatly affect the justification for the program.

As shown in the summary tabulation of estimated changes in water yield presented in this report, reduction in rate of surface runoff will increase ground-water storage, but the net effect of the program is to reduce the volume of surface runoff. The water supply of existing Bureau of Reclamation projects would, therefore, be reduced. However, the survey report attempts to compensate for this reduction through assurance that elimination of salt cedar growth on the delta above McMillan Reservoir would salvage an estimated 12,000 acre-feet of water. The report states that apportionment of salvaged waters between concerned States is covered by provisions of the Pecos River compact. However, the report emphasizes that needs of established irrigation projects should receive first consideration in the division of salvaged water. Whether these statements are entirely compatible is open to question. Furthermore, agreement as to the actual amount of the net increase in water may not be possible until reliable means are established for evaluating the effects of watershed treatment and salt cedar eradication.

The Bureau of Land Management is in general agreement with the program as outlined for the reduction of flood sediment damage and the conservation of soil and water resources. The contributions, direct and indirect, of the Bureau of Land Management to improved conditions on the watershed consist mainly of improved range management. Since 98 percent of the watershed area is grazing land, it is believed more consideration should be given to the conservation influence of improved range-management practices. This applies especially to the interrelated measures for accomplishing the program objectives. Adjustments in present use are usually the initial considerations in the conservation treatment of land.

Most of the lands administered by the Bureau of Land Management, 10.5 percent of the 21,260,800 acres in the watershed, are in the zone of moderate erosion. The sedimentation rate from Bureau of Land Management lands is likewise moderate, ranging from 0.47 to 0.73 acre-foot per square mile per year.

A strong case for conservation practices as a means of reducing flood flows and increasing forage on range lands is presented in the economic analysis of conservation treatment on range and forest lands. The summary of benefits and costs indicates a benefit-cost ratio much more favorable than that for additional measures employed.

It is noted that a comparison of the estimated monetary benefits and the estimated cost of the recommended program, heavily weighted by benefits from land-treatment measures, indicates a very favorable benefit-cost ratio which is greater than 3.0 to 1.

It is noted that about 90 percent of the estimated benefits would accrue to the owners and operators of the land on which the recommended measures would be installed. Since 64 percent of the land in the watershed is privately owned or in State ownership, some question might be raised as to whether sufficient cooperation might be secured from the owners in installing and maintaining the measures required to produce the estimated benefits. Since the estimated ratio of benefits to costs of such measures is almost 4 to 1, however, it ap-

pears likely that the actual ratio of benefits to costs would be favorable in any event.

The Bureau of Indian Affairs endorses the recommendations made in this report. In so doing, it points out that the work proposed for that portion of the Mescalero Indian Reservation in the Pecos River watershed, which amounts to some $326,000 in 15 years, is needed to augment the existing soil and moisture conservation program of that Bureau. This of course is the manner in which the entire program is presented. The Bureau of Indian Affairs further notes that the funds required for fire control have been computed on the basis of 200,000 acres at a cost of $70,000, whereas the actual acreage should be 295,000 acres with a corresponding cost of $103,000.

The Department of the Interior concurs in the objectives of the program for the Pecos River watershed. However, we reiterate our concern over water yields which may reduce the rate of surface runoff and could impair the water supply of existing irrigation projects. For these reasons we heartily endorse the program for the evaluation of the effects of the practices recommended in this report on water yields. The agencies of this Department, such as the Geological Survey, Bureau of Land Management, and Bureau of Reclamation, would welcome an opportunity to cooperate with agencies of your Department in making such evaluations.

Sincerely yours,

OSCAR CHAPMAN,
Secretary of the Interior.

LETTER FROM THE STATE ENGINEER OF NEW MEXICO TO THE SECRETARY OF AGRICULTURE

STATE OF NEW MEXICO,
OFFICE OF STATE ENGINEER,
Santa Fe, May 29, 1951.

Hon. CHARLES F. BRANNAN,
Secretary of Agriculture, Washington, D. C.

DEAR SECRETARY BRANNAN: I have been designated by Gov. Edwin L. Mechem to prepare comments on a report submitted by you entitled "Survey Report Pecos River Watershed, New Mexico and Texas, a Program for Runoff and Water Flow Retardation and Soil Erosion Prevention, July 1950."

The State of New Mexico wishes to express its appreciation for the procedure which has been adopted by your Department in the handling of this report. Although you are not required under the terms of the 1944 Flood Control Act to submit such a report for comments by the affected States, as in the case with reports of the Corps of Engineers and the Department of the Interior, nevertheless, the report has been submitted in much the same manner and the regional office at Albuquerque has worked in close cooperation with the State of New Mexico in the preparation of the report. Such procedure is commendable.

The State approves in general the plan and recommendations contained in the report. It feels that the program is a necessary part of conservation measures which are being planned and undertaken in the Pecos River Basin and should be carried on as a necessary adjunct

to the other proposed projects. In addition to the range-management program and the soil-erosion-prevention phases, this State is particularly interested in the conservation of water through the proposed eradication of salt cedar growth.

During the past year an interagency task force was created to study the salt cedar problem in New Mexico. Mr. Harold B. Elmendorf of the Soil Conservation Service, Department of Agriculture, was chairman of that committee. Some very valuable information was collected by that task force. No recommendation was made as to specific action which could be followed in the elimination and control of the salt cedars. Based on that report the engineering advisory committee to the Pecos River Commission recently recommended to the commission that a definite program for the control of the salt cedars along the Pecos River should be sought by that commission. It was apparent to the engineering committee that eradication could probably be carried out at a nominal cost per acre and that the continued control could be done within the proposed program of the Department of Agriculture. This State feels, as does the Pecos River Commission, that the program recommended in your report should be extended to all the areas of salt cedar infestation between Alamogordo Reservoir and Girvin, Tex.

The salt cedar report referred to above also contained information submitted by the Department of Agriculture regarding low-water-consuming plants which could be used as sediment control barriers in place of salt cedars. In the opinion of the Pecos River Commission engineering committee there is a possibility of using such plants for screening sediment at or near the mouths of principal sediment producing tributaries along the Pecos River. The State of New Mexico concurs in that opinion and suggests that the proposed program be expanded, at least in the beginning on an experimental basis, to include the consideration of positive sedimentation checks in the tributaries until the soil erosion prevention program can become effective throughout the entire basin.

The State of New Mexico stands ready to assist in whatever way practicable and possible in carrying out the proposed program recommended in your report.

Sincerely yours,

JOHN H. BLISS,
State Engineer.

LETTER FROM THE CHAIRMAN OF THE FEDERAL POWER COMMISSION TO THE SECRETARY OF AGRICULTURE

FEDERAL POWER COMMISSION,
Washington 25, June 1, 1951.

Subject: Pecos River watershed.

Hon. CHARLES F. BRANNAN,
Secretary of Agriculture, Washington 25, D. C.

DEAR MR. SECRETARY: The comments herein with respect to your Department's survey report on the Pecos River watershed, New Mexico and Texas, are transmitted in response to Assistant Secretary Hutchinson's letter of March 12, 1951. The transmittal of these

comments is in accordance with established procedures of the Federal Inter-Agency River Basin Committee.

The report recommends a program of runoff and water-flow retardation and soil-erosion prevention for the 33,200 square miles of contributing drainage area in the Pecos River watershed. This basin is located in eastern New Mexico and western Texas and drains into the Rio Grande. The recommended program, which would consist of stabilizing and sediment control structures, land seeding, terracing, and other measures to improve vegetative cover and conserve water resources, would be installed over a 15-year development period at an estimated cost of $20,126,300, based on 1948 prices. Of that amount $14,683,800 would be Federal expenditure. The average annual benefits are estimated at $5,555,200, and the benefit-cost ratio is shown in the report to be about 3.0.

The staff of the Commission has reviewed the report of your Department with the view, primarily, of determining whether or not the recommended plan of improvement offers any possibilities for hydroelectric power development, and of ascertaining the effects of the plan on existing or potential hydroelectric power plants. The proposed improvements, consisting principally of measures to be applied to the soil to secure a balanced runoff and erosion-control program, would not be adaptable generally to the development of power. The only proposed structure capable of storing a significant amount of water is the Capitan detention dam to be located on Salado Creek, a tributary of Rio Bonito. That dam, with an ungated outlet, could impound temporarily up to 4,400 acre-feet of floodwaters. The average annual runoff from the 120 square miles above the site is estimated at less than 10 cubic feet per second. The staff studies show that the development of power at this dam would not be practicable.

The only existing hydroelectric project in the basin subject to the effects of the proposed plan is the 2,300-kilowatt plant of the Red Bluff Water Power Control District, located on the Pecos River about 10 miles below the Texas-New Mexico State line. On the lower reaches of the Pecos River below Girvin, Tex., there is a fall of some 1,100 feet which preliminary staff studies indicate may be possible of full or partial development for power. The report of your Department estimates that the recommended land-treatment measures would result in a net reduction in flow at the Red Bluff Reservoir, amounting on the average to about 9,000 acre-feet annually. On the other hand, the proposed eradication of the salt cedar growth in the delta area of Lake McMillan is estimated to permit the salvaging of about 21,000 acre-feet of water annually for beneficial uses. It appears, therefore, that the over-all effects of the proposed improvements would be a small increase in the flows available for power development and other purposes in the Pecos River at Red Bluff Reservoir and points downstream. The effects of the program in retarding the movement of sediment into the reservoirs of the basin and prolonging their useful lives would also be beneficial to power development.

Based on its consideration of the report of your Department and on the studies by its own staff, the Commission concludes that the recommended improvements would not be adaptable to the production of hydroelectric power, and that the proposed program would have a

relatively small but apparently beneficial effect on existing and potential power developments in the Pecos River watershed.

The Commission appreciates the opportunity of reviewing and commenting on the report of your Department.

Sincerely yours,

MON C. WALLGREN, *Chairman.*

LETTER FROM THE ASSISTANT SURGEON GENERAL TO THE SECRETARY OF AGRICULTURE

FEDERAL SECURITY AGENCY,
PUBLIC HEALTH SERVICE,
Washington 25, D. C., April 25, 1951.

Hon. CHARLES F. BRANNAN,
Secretary of Agriculture, Washington 25, D. C.

DEAR MR. SECRETARY: Pursuant to the policies and procedures established by the Federal Interagency River Basin Committee, we have reviewed the preliminary report furnished by your Department entitled Pecos River Watershed, New Mexico and Texas (report and appendix).

The only comment we have concerning this report is that consideration might be given to the effects, if any, that the proposed program might have on minimum stream flows and the benefits which may accrue from the dilution of salt waters encountered in the lower reaches of the stream.

A copy of this letter is being furnished the Secretary of the Federal Interagency River Basin Committee for his information.

Sincerely yours,

MARK D. HOLLIS,
Assistant Surgeon General, Chief Sanitary Engineering Officer
FSA Member, Federal Interagency River Basin Committee.

UNITED STATES DEPARTMENT OF AGRICULTURE

SURVEY REPORT
PECOS RIVER WATERSHED
NEW MEXICO AND TEXAS

Program for Runoff and Water-Flow Retardation and Soil-Erosion Prevention

Pursuant to the Act approved June 22, 1936 (49 Stat. 1570), as amended and supplemented

JULY 1950

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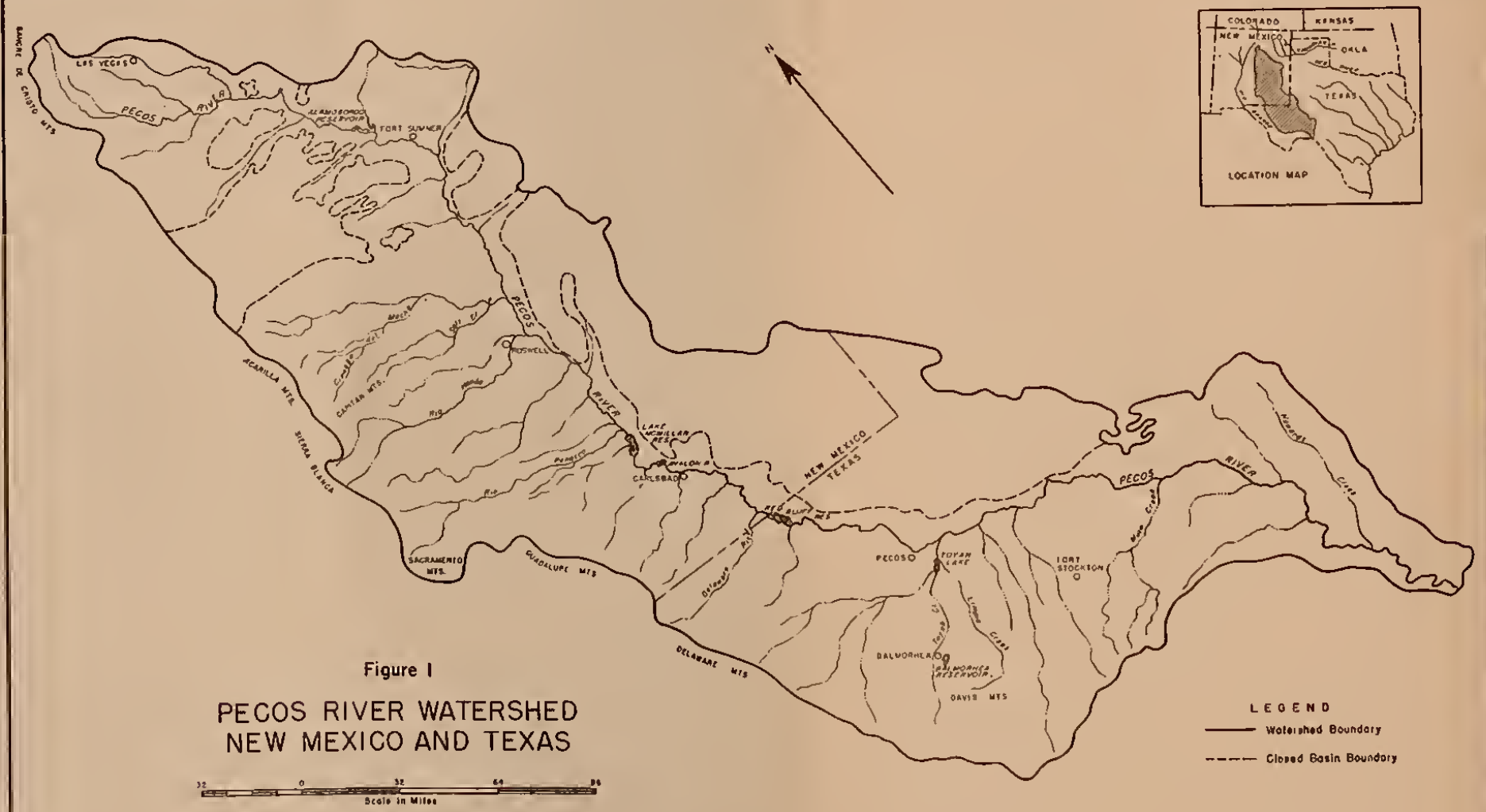

Figure 1

PECOS RIVER WATERSHED NEW MEXICO AND TEXAS

Base Map Developed from Corps of Engineers, U.S. Army; Pecos River Joint Investigations; and Others.

MAY 1948

SOUTHWEST REGION

6-L-12998-L

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OUTLINE OF APPENDIX MADE IN CONNECTION WITH THE REPORT (NOT PRINTED IN THIS DOCUMENT)

1. Past and current activities related to flood control.
2. Hydrology.
3. Sedimentation.
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SURVEY REPORT, PECOS RIVER WATERSHED, NEW MEXICO AND TEXAS

INTRODUCTION

Authority.—This report is submitted under the provisions of the act approved June 22, 1936 (49 Stat. 1570), as amended and supplemented.

Purpose and scope of report.—The purpose of this report is to outline a program of runoff and waterflow retardation and soil-erosion prevention for the Pecos River watershed in New Mexico and Texas, and to present recommendations for installing and maintaining the program, together with a comparison of its benefit and cost.

The Pecos River, a tributary of the Rio Grande, has a contributing drainage area of 33,200 square miles (21,260,800 acres). This basin is situated in eastern New Mexico and western Texas (fig. 1).

RECOMMENDATIONS

It is recommended that a program of runoff and waterflow retardation and soil-erosion prevention be installed during a 15-year period in the Pecos River watershed in New Mexico and Texas at an estimated cost of $14,683,800 to the Federal Government, and at an estimated cost of $5,442,500 or its equivalent [1] to local interests, making an estimated total cost of $20,126,300 for the installation of the program.

The program will be operated and maintained at an estimated annual cost of $115,975 to the Federal Government and $221,865 or its equivalent to local interests, making an estimated total annual cost of $337,840 for operating and maintaining the program.

The recommended program is designed to reduce floodwater and sediment damage and to conserve soil and water resources. There are interdependent measures which will accomplish these objectives. They are: Stabilizing and sediment-control structures, range improvement, road-erosion control, diversion dikes and ditches, work roads, fire control, land acquisition, terracing, crop-residue management, grass waterways, land leveling, erosion-control structures, channel improvement, stream-bank protection, floodway systems, a detention structure, salt-cedar eradication and control, and other soil- and water-conservation practices and measures applied in proper combination with the above listed measures which will make up a comprehensive program of soil and water conservation in accordance with the needs and capabilities of the land of the watershed.

Educational assistance and technical services provided under this program will be synchronized and adapted toward the specific objectives of floodwater and sediment-damage reductions.

[1] Labor, materials, equipment, land, easements, rights-of-way, and other contributions in lieu of cash payments.

The Secretary of Agriculture, or the head of any other Federal agency concerned, may make such modifications or substitutions of the measures described in this report as may be deemed advisable, due to changed physical or economic conditions or improved techniques, whenever he determines that such action will be in furtherance of the objectives of the recommended program.

The measures included in the recommended program will be installed on non-Federal land under cooperative arrangements with State and local governments, soil conservation districts, or other agencies acceptable to the Secretary of Agriculture.

The ratio of the estimated average annual value of the total benefit to the estimated average annual value of the total cost of the recommended program is 3 to 1.[2]

The program herein recommended includes the intensification, acceleration, or adaptation of certain activities under the current programs of Federal agencies in the watershed, and additional measures not now regularly carried out in such programs, all of which are necessary to complete a balanced runoff and water-flow retardation and erosion-control program for the watershed. It is recommended that the Secretary of Agriculture be authorized to carry out all of this program except the part which is proposed for installation on land under the jurisdiction of a Federal agency other than the Department of Agriculture. It is further recommended that the head of such other Federal agency be authorized to carry out the part of the program which is proposed for installation on land under the jurisdiction of such agency. Although the current activities of Federal agencies in the watershed which are primarily related to the objectives of the Flood Control Act are not included in the program herein specifically recommended, the program is based on the continuation of such activities at least at their present level.

The Secretary of Agriculture or the head of any other Federal agency concerned may construct such buildings and other improvements as are needed to carry out the measures included in the recommended program.

The authority of the Secretary of Agriculture or of the head of any other Federal agency concerned to prosecute the recommended program shall be supplemental to all other authority vested in him, and nothing in this report shall be construed to limit the exercise of powers heretofore or hereafter conferred on him by law to carry out any of the measures described herein or any other measures that are similar or related to the measures described herein.

DESCRIPTION OF WATERSHED

The Pecos River watershed heads above Las Vegas in the mountains of north-central New Mexico and extends southward across western Texas to the Rio Grande (fig. 1). The watershed contains about 33,200 square miles (21,260,800 acres), of which 17,300 square miles are in New Mexico and 15,900 are in Texas. This is the area which contributes surface flow to the main stream.

The Pecos River Basin lies in the extreme southwestern portion of the Great Plains. It is bordered on the north by the Sangre de

[2] Comparison of benefits and costs based on future price and cost levels assumed to prevail under an intermediate level of employment.

Cristo Mountain Range, on the west by foothills and by Jicarilla, Sierra Blanca, Sacramento, Guadalupe, Delaware, and Davis Mountains, and on the east by low foothills and the Staked Plains. The drainage pattern is well developed. Streams in the northern and southern sections are deeply entrenched. The distinguishing feature of the middle basin is the large area 200 miles long and 10 to 30 miles wide which has nearly level or gently sloping topography. Elevations range from about 1,000 feet at the confluence of the Pecos River and Rio Grande to 13,000 feet in the Sangre de Cristo Mountains (fig. 1).

The major tributary drainages are the Gallinas River, Rio Hondo, Rio Penasco, and Tecolote, Alamogordo, Cienega del Macho, Toyah and Limpia Creeks. Generally, these are intermittent streams, except in their upper reaches. The mountain sections of tributary channels are deep and have steep gradients which gradually flatten in the lower reaches.

Shallow soils 10 inches or less in depth occur on 55 percent of the watershed; medium-depth soils of from 10 to 30 inches occupy 24 percent, and deep soils of over 30 inches occur on 21 percent.

Generally the soils are medium to heavy textured. Short-grass plains occupy 32 percent of the watershed, desert shrub grassland 31 percent, desert grassland 18 percent, piñon-juniper woodland 14 percent, and coniferous timber 5 percent. Erosion is severe on 7 percent of the watershed, moderate on 59 percent, and slight on 34 percent.

United States Weather Bureau records of 6 to 35 years show that precipitation ranges from 10 to 12 inches in the central valleys to 35 inches or more in the mountainous areas. The mean annual temperature ranges from 69° F. at Del Rio, Tex., to 41° F. at Harvey's Ranch in the upper watershed. Temperatures ranging up to 114° F. have been recorded at Barstow and Fort Stockton, Tex. A low temperature of minus 31° F. has been recorded at Las Vegas, N. Mex. The growing season varies from 155 frost-free days at Las Vegas, N. Mex., to 277 frost-free days at Del Rio, Tex.

The population of the watershed was about 150,000 in 1940. About 92,000 persons resided in rural areas and 58,000 in urban centers. The rural population is concentrated in the upper tributary areas where the size of most of the farms is less than 15 acres. The 1940 census report shows that 67 percent of the population is in New Mexico and 33 percent in Texas.

Ninety-eight percent of the watershed is used for grazing, and the remainder is cropland. The gross value of crops produced on irrigated land in 1948 is estimated at $26,000,000 and the gross value of crops produced in dry-farm land is estimated at $2,200,000. About $30,000,000 worth of livestock and livestock products were produced in 1948, and about $1,563,000 worth of timber products were harvested that year. Sixty-four percent of the land in the watershed is privately owned, 18 percent State owned, and 18 percent federally owned or administered. All federally owned or administered land is situated in New Mexico. This land includes national forests (5 percent of the watershed), public domain (11 percent), and Indian reservation (2 percent). State land is found in both New Mexico and Texas.

The watershed was originally protected by a vegetative cover that retarded runoff and prevented soil erosion. Heavy grazing, par-

ticularly during the forepart of the twentieth century and during drought periods, has resulted in the deterioration of the protective cover over much of the watershed. Plant vigor has been lowered and inferior grasses and shrubs have invaded the range land, changing the composition of the cover and reducing its effectiveness in retarding runoff. This change in range condition has occurred particularly in the lower elevations where undesirable brush has invaded large areas of grassland. Improper location of early roads and trails has contributed to valley trenching. As a result of the change in range condition, runoff from intense summer rainfall has been accelerated and sediment movement downstream has increased. Topsoil removed from the watershed by sheet and gully erosion and alluvium removed by valley trenching lodges in irrigation reservoirs, canals, and ditches. The deposition of infertile debris on highly developed farm land causes a heavy loss in crop production. Stream bank erosion is also aggravated by the higher rate of runoff from watershed lands. Records show that a large part of the bank caving has occurred during the past 50 years.

FLOOD PROBLEMS

Floods in the Pecos River watershed damage crops, farm land, irrigation systems, towns, highways, railroads, and utilities. During a 15-year period, 1932 to 1947, 12 floods in the watershed caused damage estimated at more than $9,000,000.

Floods usually occur during the season from May to October when growing crops are subject to damage. A major item of flood damage is the loss of crops. General storms produce high peak discharges in both the main stream and in tributaries. Although the high peak flows produced in the tributaries by local storms are reduced to nondamaging proportions after reaching the main stream, they transport considerable sediment into the main channel.

Agricultural losses due to floods have been confined largely to damage to crops by inundation, loss of land by stream bank cutting, destruction of diversion dams, and sedimentation of reservoirs.

Four reservoirs located on the main channel of the Pecos River store water for irrigation projects which serve about 100,000 acres of land. The storage capacity of these and other off-channel reservoirs is being depleted by sediment. Sufficient storage capacity was provided in the major reservoirs to meet irrigation requirements of more than 1 year because of the need of carrying over a water supply into years of low flow. The capacity depletion results in increasing water losses by causing spills when stream flow is high. Sediment accumulation shortens the useful life of the reservoirs and thus adds to the cost of operating irrigation projects. Operation costs are increased by the expense of cleaning irrigation canals and ditches. Sediment accumulation on farm land results in expensive removal or land-leveling operations.

Other kinds of flood damage are the destruction of homes, personal property, farm and ranch improvements, machinery and equipment, loss of livestock, loss of life (23 persons perished during the 1941 floods), loss of business, and less water for irrigation. Table 1 shows the monetary evaluation of the average annual floodwater and sediment damage in the Pecos River watershed.

TABLE 1.—*Estimated average annual monetary damages in the Pecos River watershed*

Type of damage:	*Average annual damages (1948 prices)*
Floodwater:	
Agricultural, cropland, irrigation systems	$454, 900
Nonagricultural, urban, and public utility	100, 300
Subtotal	555, 200
Sediment: Reservoir sedimentation	377, 800
Total average annual damage	933, 000

ACTIVITIES RELATED TO FLOOD CONTROL

Department of the Army, Corps of Engineers.—The Corps of Engineers is conducting a general flood-control survey in the watershed. Recommendations contained herein have been correlated with the contemplated program of the Corps of Engineers in order to provide the most complete flood protection that is feasible. Particular attention has been given to the evaluation of program recommendations to avoid duplicating benefits credited to works of improvement under consideration by the Corps of Engineers.

Department of the Interior.—The Bureau of Land Management administers more than 2 million acres of public domain grazing land within the Pecos River watershed in New Mexico, pursuant to the Taylor Grazing Act of 1934. (There exists no public domain in the State of Texas.) Most of this public domain lies within an established grazing district, with headquarters at Roswell. The bulk of the remainder occurs in a widely dispersed pattern in the watershed above Fort Sumner. BLM's contribution to land and water conservation on the watershed consists principally of improved range management. However, in addition, it controls range fires, installs needed range improvements, and carries on a limited amount of strictly soil- and moisture-conservation operations. All of the foregoing either directly or indirectly improve watershed conditions and aid in flood control.

The Bureau of Reclamation has a soil- and moisture-conservation program in progress on its lands situated above Alamogordo Reservoir. Operations on this area are being coordinated with other land-treatment measures and with plans for conservation work on privately owned land. The Bureau and the Carlsbad Irrigation District are testing methods of eradicating salt cedar from the sediment delta above Lake McMillan. This project includes studies of water saving in the area, of rate of sediment accumulation on the delta, and of the establishment of useful vegetation on the site. Results of the investigations will be used in estimating the effectiveness of a channel through the delta as a water-saving measure, which is being considered by the Carlsbad Irrigation District.

The Bureau of Indian Affairs administers the Mescalero-Apache Indian Reservation, which has a land area of 294,000 acres in the Pecos River watershed. Soil conservation and management practices being carried out on the reservation are aiding in the reduction of floodwater and sediment damages.

The Fish and Wildlife Service directs rodent-control work in the watershed in cooperation with appropriate State and local agencies. This work aids in improving the vegetative cover of the watershed.

The National Park Service administers 49,742 acres in the Carlsbad Caverns National Park. Management, revegetation, and structural measures are being carried out in the park to perpetuate its scenic and recreational value and at the same time to aid in flood control.

The current annual cost of the activities related to flood control which are directed by the Department of the Interior is estimated at $44,000.

Department of Agriculture.—The Forest Service administers 1,157,120 acres of Federal lands which form the headwaters of the Pecos River and its tributaries. These lands are a part of the Cibola, the Lincoln, and the Santa Fe National Forests. These national forests were established for the primary purpose of promoting watershed protection, and their management has stressed the control of fire and destructive insects, and the regulation of livestock use and logging operations. Current activities also include range reseeding, road construction and maintenance, rodent control, construction of range fences and water developments. Recreation and other public uses of these lands are also supervised and regulated in the interest of watershed protection.

The Soil Conservation Service assists 25 soil conservation districts within the watershed in the planning and application of effective programs of soil and water conservation on private and State land. Certain measures and practices applied under district programs contribute to runoff retardation and soil-erosion prevention. These include revegetation, contour furrowing, terracing, land leveling, crop residue management, and structures such as diversions, dams, and dikes.

The Production and Marketing Administration makes direct aids available to farmers and ranchers who participate in the agricultural conservation program to cover a portion of the cost of establishing approved conservation practices. These direct aids are helping with the installation of such measures as terracing, leveling, crop residue management, grass seeding, contour furrowing, construction of dams and dikes, all of which will reduce runoff and sediment from the land treated.

The Extension Service cooperates with the States of Texas and New Mexico in performing its function of conservation education. A part of its educational program in rural areas throughout the watershed encourages and aids the application of practices and measures considered necessary to achieve flood-control objectives.

The Farmers Home Administration furnishes financial and technical assistance to farmers and ranchers for the purpose of making improvements to their land which will conserve moisture and prevent erosion. Some of the measures which are carried out under this program contribute to flood-control objectives.

The annual cost of the current activities of the Department of Agriculture in the watershed which are related to flood control is estimated at $413,600.

Municipalities and States.—Roswell, N. Mex., and Pecos, Tex., have done some flood-protection work which reduces floodwater damage in these communities.

Twenty-five soil conservation districts have been organized under State law in the Pecos River watershed. Landowners have developed a conservation program for the land within the districts and individual

farm and ranch plans have been developed for many units. Many measures being applied are improving watershed conditions and contribute to flood-control objectives.

RECOMMENDED PROGRAM

The program for runoff and water-flow retardation and soil-erosion prevention herein recommended was developed in part from studies of sample areas which are representative of conditions throughout the watershed and in part through consultation with Federal, State, and local agencies having an interest in program objectives. Present conditions of the sample areas were examined in detail to determine floodwater and sediment damages and the kinds and amounts of practices and measures required for the most effective treatment to reduce the damages. The data obtained by the sampling procedure were applied to similar areas in the watershed as a basis for planning and recommending the proper combination of measures needed to accomplish flood-control objectives.

The recommended program will substantially reduce floodwater and sediment damage and will improve the productivity of watershed lands. Watershed-treatment measures are designed to improve vegetative cover which will improve soil characteristics and thereby increase the infiltration rate of rainfall into the soil, decrease surface runoff and control the water that runs off so that it does a minimum of damage on its way into the rivers and waterways. By retarding the rate of runoff and reducing the loss of soil by erosion, the program provides direct benefits in the reduction of damages caused by floodwaters and sediment. Measures carried out will be adapted wherever possible to improve wildlife resources in addition to serving their primary purposes.

The recommended program consists of the following interrelated measures. The approximate number of each of these measures is shown in table 2.

Stabilizing and sediment-control structures.—Eroding gullies on range and forest land are the source of much of the sediment which damages downstream areas. Water quickly collects in the gullies during storms, and runoff and erosion are accelerated. Stabilizing structures will be installed in the active gullies to retard waterflow and prevent additional trenching. When the site is stabilized, vegetation will become established, thus completing the protection to the treated areas and furnishing more forage for livestock. It is estimated that 28,500 structures are needed to stabilize the areas where gullies are so critical that structural treatment is the only effective treatment. The less severely eroded areas will be stabilized by improved vegetation which will result from proper range management.

Range improvement.—(*a*) The improvement of vegetative cover on 10 million acres of range and forest land is one of the most important phases of the recommended program. Changes which are expected in range and forest conditions will retard runoff, reduce rates of erosion and sediment production, and increase forage production. Most of the rehabilitation of watershed lands will be accomplished by natural processes of revegetation under proper management. Critical areas will receive additional treatment. The range land that is

depleted will be seeded to grass where favorable sites exist or are developed. Out of the total area within the watershed which needs reseeding, an estimated 182,000 acres are adapted to this treatment, including some cultivated land which is not suited to crop production. All seeded areas will be protected from grazing use until the grass is established.

(*b*) Additional stockwater facilities are needed for better distribution of livestock. These facilities will permit the use of lands which can only be partially utilized until water is supplied and will alleviate concentration of use which occurs now in some localities. It is estimated that 113 units, consisting of wells and stock ponds, should be installed under the program recommended herein.

(*c*) More fences are needed to obtain better distribution of livestock and thus aid in the improvement of vegetation. The amount of fencing needed to carry out the range-management phase of the program is estimated at 685 miles.

(*d*) An area of approximately 378,125 acres in the watershed needs rodent-control work to assist with the establishment of vegetative cover and to maintain it.

Road-erosion control.—Accelerated runoff along roadsides which are not protected by vegetation or structures results in serious erosion and the development of gullies. Water-disposal systems will be installed at suitable sites along the 2,225 miles of roads recommended for treatment. Other measures include retard structures and vegetative treatment.

Diversion dikes and ditches.—The installation of diversion structures on range land will divert runoff from channels to prevent rapid water concentration. Waterways which are being trenched or destroyed by head-cuts will be protected by a diversion dike and a system of ditches. Diversions will be installed above cultivated fields so that runoff can be carried away without damage to lands situated below the structures. It is estimated that 2,729 miles of diversion dikes and ditches will be installed on the watershed. Approximately 415 miles are on range land, 1,014 miles on dry-farm land, and 1,300 miles will protect irrigated land.

Work roads.—To install measures in inaccessible areas of Federal lands, it will be necessary to construct approximately 30 miles of work roads.

Fire control.—More complete fire control is needed for 3,870,000 acres of range and forest land. The improvements proposed will prevent many fires and will speed up the suppression of fires when they occur, thus reducing the areas of grass and timber land destroyed. Fire-control measures will contribute to the maintenance of good watershed conditions.

Land acquisition.—Approximately 60,000 acres of private lands within and adjacent to national forests which are critical flood-and-sediment-source areas will be acquired by the Federal Government for watershed protection. Because of the poor quality of the land and its low financial returns, the lands involved are not properly managed for watershed protection and timber production. The acquisition of these lands will facilitate the application of conservation measures and proper management needed to bring about an improvement in cover conditions.

Terracing.—Terraces will be installed on dry-farm land to control runoff and reduce soil erosion on cultivated fields. Approximately 2,755 miles of terraces will be installed on the sloping lands that are the source of damaging runoff and sediment under present conditions.

Crop-residue management.—The proper use of crop residue to provide conditions favorable for higher infiltration rates will retard runoff and reduce erosion on the areas treated. This practice will be required for 24,000 acres of nonirrigated cropland.

Grass waterways.—Grass waterways will be developed in natural water courses to provide a disposal system for excess water from farm land. The grassed strips will extend through cultivated fields and beyond them to carry runoff into channels without damage. The amount of waterways needed to protect farm land is estimated at 2,050 acres.

Land leveling.—In the upper reaches of the Pecos River and its principal tributaries a large area of land is irrigated by diverting water from streams. Most of the land has considerable slope, and soil erosion is a serious problem, making the irrigated fields an important source of sediment. To reduce erosion and improve water use, 45,000 acres of the irrigated land will be leveled.

Erosion-control structures.—In order to control the application of irrigation water on the land to be leveled and to dispose of excess water, about 500 erosion-control structures will be installed.

Channel improvement.—About 2.5 miles of stream channel will be improved by straightening, enlarging, and stabilizing, so that the flow of floodwater through high damage areas can be regulated.

Stream-bank protection.—Approximately 45.5 miles of stream bank along the main stream and its important tributaries will be protected to prevent bank cutting. The protective measures are designed to prevent the loss of highly developed irrigated land. The reduction in land losses will lower the rate at which reservoirs are filling with sediment.

Floodway systems.—Lands in tributary watersheds which have been developed for irrigation will be protected from overflow damage by floodway systems. Flood flows will be routed through the farm land by means of protective dikes to prevent overflow, and detention structures may be used to reduce the discharge. The floodway will protect crops from inundation and will prevent the deposition of infertile material on farm land. It is estimated that 14 miles of floodways will be installed to protect irrigated land in the tributary areas.

Detention structure.—In order to reduce floodwater damage to high value irrigated farm land along the Rio Bonita and the Rio Hondo, a detention structure will be constructed on Salado Creek, a tributary to Rio Bonita. The proposed Capitan floodwater detention structure is designed to control floods of 100-year frequency from Salado Creek. An ungated outlet will gradually release water so that damage will be reduced downstream.

Salt-cedar eradication and control.—The elimination of the salt-cedar growth on the 14,000-acre delta area above Lake McMillan will salvage a substantial amount of water for beneficial use. The salt cedar will be eradicated, and adapted grasses and other vegetation that use less water than salt cedar will be established on the area.

Other conservation practices and measures.—Additional soil- and water-conservation practices and measures will be applied as needed for a complete conservation program to meet the needs and capabilities of the land of the watershed.

The quantities of measures included in the recommended program are based on the total watershed needs less the estimated accomplishments under "going" programs over a 15-year period. The income of farm and woodland operators is expected to increase materially as the recommended program is installed and becomes effective. No major changes in the acreages of crops are anticipated.

Educational assistance.—Additional educational assistance will be provided to inform landowners and operators about the need of the recommended program, its purposes and objectives, and how the services available through action agencies can be secured to help establish the recommended program. Through the educational activities, land operators will be trained in the methods of installing land-treatment measures which do not require technicians to design them and supervise their installation. Educational efforts will be intensified to develop widespread interest in the recommended program and to speed up the rate at which measures are applied.

Technical services.—Technical services will be furnished to help plan and apply an effective program of soil and water conservation on watershed lands.

Direct aids.—A portion of the cost of establishing certain land-treatment measures on non-Federal lands will be provided in the form of direct aids.

Program evaluation.—Investigations and studies of program installations will be conducted in selected subwatersheds to determine their effectiveness and adequacy for runoff and waterflow retardation and soil-erosion prevention. The evaluation of the program may indicate changes needed in the application of land-treatment measures to make them more effective in reducing floodwater and sediment damages.

COST OF THE RECOMMENDED PROGRAM

The estimated cost of installing the recommended program in the Pecos River watershed is $20,126,300. Of this cost, it is estimated that the Federal Government will expend $14,683,800; non-Federal public agencies, $388,000; and private interests, $5,054,500. The total cost of the recommended program and the sharing of responsibility for installation are based on experience with land operators in the application of measures and practices similar to those herein recommended.

Federal participation will include educational assistance, technical services, materials, planting stock, special equipment, and direct aids where appropriate and needed to assist with the installation and maintenance of the recommended practices and measures.

The estimated average annual cost of operating and maintaining the recommended program is $337,840. Of this amount, the Federal Government will expend $115,975; non-Federal public agencies, $47,730; and private interests, $174,135. The Federal Government will provide (1) maintenance of measures which it has installed, from the time of completion of such measures to the time of transfer to a local agency for operation; (2) operation and maintenance of measures

installed on land owned and land acquired by the Federal Government; (3) one-half the cost of maintaining adequate fire control on non-Federal-owned woodland, and (4) one-half the cost of educational assistance and one-half the cost of technical services on non-Federal-owned woodland. Non-Federal public agencies will bear one-half the cost of educational assistance and one-half the cost of technical services on non-Federal-owned woodland.

The estimated cost of installing the recommended program in the Pecos River watershed is shown in table 2.

TABLE 2.—*Estimated cost of installing the recommended program in the Pecos River watershed*

Item	Unit	Approximate number	Cost (1948 prices)
Stabilizing and sediment-control structures	Each	28, 500	$6, 665, 000
Range improvement:			
(*a*) Grass seeding	Acre	182, 000	2, 322, 000
(*b*) Stockwater facilities	Each	113	527, 000
(*c*) Fencing	Mile	685	585, 000
(*d*) Rodent control	Acre	378, 125	174, 000
Road-erosion control	Mile	2, 225	291, 000
Diversion dikes and ditches	do	2, 729	573, 000
Work roads	do	30	13, 500
Fire control	Acre	3, 870, 000	781, 000
Land acquisition	do	60, 000	394, 000
Terracing	Mile	2, 755	517, 000
Crop-residue management	Acre	24, 000	55, 000
Grass waterways	do	2, 050	119, 000
Land leveling	do	45, 000	3, 559, 000
Erosion-control structures	Each	500	492, 800
Channel improvement	Mile	2. 5	173, 000
Stream-bank protection	do	45. 5	1, 107, 000
Floodway systems	do	14	325, 000
Detention structure	Each	1	403, 000
Salt-cedar eradication and control	Acre	14, 000	1, 050, 000
Total			20, 126, 300

The costs of technical services, educational assistance, program evaluation, and administration of direct aids are included and make up 22.8 percent of the total cost of the recommended program.

BENEFITS FROM THE RECOMMENDED PROGRAM

The principal monetary benefits that will result from carrying out the recommended program are reductions in floodwater damage, reductions in sediment damage, increased forage, timber, and crop production, and an increased water supply.

Benefits from reduction in floodwater damage.—The recommended program will reduce the damage caused by small floods, which occur most frequently, by 90 percent. There will be a reduction in peak flows and damages caused by larger, infrequent floods, but the effect of the program will be less than in the case of the small flood. Most of the floodwater-reduction benefits will accrue to agricultural interests in the highly developed irrigated areas in the Pecos River watershed. Deposition of infertile material on cropland and loss of farm land by stream bank erosion will be reduced by land-treatment measures which will reduce flood peaks and by stream-bank stabilization work. Agricultural benefits account for about three-fourths of the floodwater-reduction benefits. The remaining floodwater-reduction benefits will accrue to urban areas, roads, railroads, and to public utilities. It is estimated that the recommended program, when properly installed and adequately maintained, will reduce floodwater damages about 50 percent.

Benefits from reduction in sedimentation.—The chief benefit which will result from a lower rate of sediment production on the watershed as a result of the recommended program will accrue to irrigation interests. Lower sedimentation rates in the storage reservoirs of irrigation companies will extend the useful life of the facilities, and greater capacities will be available to carry over water supplies. The average annual damage to reservoirs by sediment is expected to be reduced by an estimated 23 percent.

Benefits from increased forage, timber, and crop production.—Increased forage production which will result from land-treatment measures on range land makes up most of the conservation benefits of the program. The predominant use of watershed land is livestock grazing. It is estimated that forage production on 10 million acres of range land can be increased by 417,000 tons annually by proper range management and other recommended land-treatment measures. Reseeding of depleted range land and abandoned cropland will increase forage production by an additional 55,000 tons annually. Measures recommended for farm land will conserve soil and moisture and will result in greater crop yields. The program of watershed management will increase timber production by a more adequate system of fire control. Conservation benefits accruing to watershed lands as a result of the recommended program are estimated to be 90 percent of the total benefits.

The benefit which will result from the eradication of salt cedar is a saving of irrigation water estimated to be 12,000 acre-feet annually.

Intangible benefits were not assigned a monetary value. Hence important benefits are not included in the table of benefits. Some of these are the prevention of loss of human life by reducing the destructiveness of flash floods which overtake occupied areas before they can be evacuated. A reduction in the frequency of flooding will prevent the development of unsanitary conditions which are hazards to health. Elimination of much of the inundation by small floods and a reduction in the depth of inundation by floods of greater magnitude will reduce the occurrence of costly detours or delays in transportation services, and interruption in business activities. Improvements of vegetative cover throughout the watershed which will hold and build soil will also provide food and cover for wildlife. These improvements will also increase the values of the watershed for recreational uses, such as camping, picnicking, and hunting.

The estimated average annual benefits resulting from the recommended program for the Pecos River watershed are shown in table 3.

TABLE 3.—*Estimated average annual monetary benefit from the program recommended for the Pecos River watershed*

Source:	*Average annual benefit (1948 prices)*
Reduction of floodwater damage:	
Agricultural: Cropland, irrigation systems	$221, 800
Nonagricultural: Urban and public utility	48, 700
Subtotal	270, 500
Reduction of sediment damage: Reservoir sedimentation	89, 200
Other benefits:	
Increased water yield	189, 000
Conservation benefits [1]	5, 006, 500
Subtotal	5, 195, 500
Total average annual benefit	5, 555, 200

[1] The benefit which accrues to the owners and operators of the land on which the recommended measures are installed.

COMPARISON OF BENEFITS AND COSTS

A comparison of the benefits anticipated to accrue from carrying out the recommended practices and measures with the probable costs thereof has been made by converting both benefit and cost estimates to average annual values.

Because prices will vary during the installation period, comparisons of the estimated average annual benefits and costs have been made on the basis of price and cost levels assumed to prevail under an intermediate level of employment. A 2½ percent interest rate was used to convert total Federal and non-Federal public costs to an average annual equivalent cost, and a 4-percent interest rate was used to convert total private installation costs to an average annual equivalent cost. This was done in order that there might be a clearer understanding of probable benefits that will accrue from the recommended program and probable costs to be incurred in the installation of the program.

The basis for the adjustments in determining this benefit-cost ratio is as follows:

Index of prices received by farmers 287 to 150 (1910–14=100).

Index of prices paid by farmers 249 to 165 (1910–14=100).

Index of construction cost of earthwork 159 to 122 (ICC index 1910–14=100).

Index of other construction costs 461 to 325 (1913=100).

In order that installation costs and resulting benefits could be directly compared, delayed benefits were discounted to allow for the lag in effectiveness.

The benefit-cost ratio, computed on a common-time basis and with the use of price and cost levels assumed to prevail under an intermediate level of employment, is 3.0 to 1.

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